

(19) World Intellectual Property  
Organization  
International Bureau



(43) International Publication Date  
29 September 2005 (29.09.2005)

PCT

(10) International Publication Number  
**WO 2005/090768 A1**

- (51) International Patent Classification<sup>7</sup>: **F02D 41/30**
- (21) International Application Number:  
PCT/JP2005/006230
- (22) International Filing Date: 24 March 2005 (24.03.2005)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data:  
2004-86098 24 March 2004 (24.03.2004) JP
- (71) Applicant (for all designated States except US): **TOYOTA JIDOSHA KABUSHIKI KAISHA** [JP/JP]; 1, Toyota-cho, Toyota-shi, Aichi 471-8571 (JP).

- (72) Inventors; and
- (75) Inventors/Applicants (for US only): **INAGAKI, Kazuhisa** [JP/JP]; c/o Kabushiki Kaisha, Toyota Chuo Kenkyusyo, 41-1, Aza Yokomichi, Oaza Nagakute, Nagakute-cho, Aichi-gun, Aichi 480-1192 (JP). **WAKISAKA, Yoshifumi** [JP/JP]; c/o Kabushiki Kaisha, Toyota Chuo Kenkyusyo, 41-1, Aza Yokomichi, Oaza Nagakute, Nagakute-cho, Aichi-gun, Aichi 480-1192 (JP). **UEDA, Matsuei** [JP/JP]; c/o Kabushiki Kaisha, Toyota Chuo Kenkyusyo, 41-1, Aza Yokomichi, Oaza

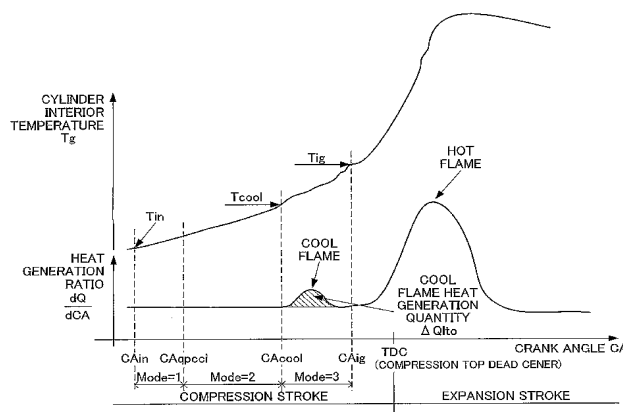
Nagakute, Nagakute-cho, Aichi-gun, Aichi 480-1192 (JP). **NAKAKITA, Kiyomi** [JP/JP]; c/o Kabushiki Kaisha, Toyota Chuo Kenkyusyo, 41-1, Aza Yokomichi, Oaza Nagakute, Nagakute-cho, Aichi-gun, Aichi 480-1192 (JP). **NAKAYAMA, Shigeki** [JP/JP]; c/o Toyota Jidosha Kabushiki Kaisha, 1, Toyota-cho, Toyota-shi, Aichi 471-8571 (JP). **KITANO, Koji** [JP/JP]; c/o Toyota Jidosha Kabushiki Kaisha, 1, Toyota-cho, Toyota-shi, Aichi 471-8571 (JP). **AOYAMA, Taro** [JP/JP]; c/o Toyota Jidosha Kabushiki Kaisha, 1, Toyota-cho, Toyota-shi, Aichi 471-8571 (JP). **HASEGAWA, Ryo** [JP/JP]; c/o Toyota Jidosha Kabushiki Kaisha, 1, Toyota-cho, Toyota-shi, Aichi 471-8571 (JP). **KOYAMA, Takashi** [JP/JP]; c/o Toyota Jidosha Kabushiki Kaisha, 1, Toyota-cho, Toyota-shi, Aichi 471-8571 (JP).

- (74) Agent: **PROSPEC PATENT FIRM**; 12th Floor, Nagoya-KS Building, 1-18, Taiko 3-chome, Nakamura-ku, Nagoya-shi, Aichi 453-0801 (JP).

- (81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NI, NO, NZ, OM, PG, PH,

[Continued on next page]

- (54) Title: GAS-MIXTURE-IGNITION-TIME ESTIMATION APPARATUS FOR INTERNAL COMBUSTION ENGINE AND CONTROL APPARATUS FOR INTERNAL COMBUSTION ENGINE



- (57) Abstract: A gas-mixture-ignition-time estimation apparatus for an internal combustion engine estimates the temperature of a premixed gas mixture for PCCI combustion (i.e., cylinder interior temperature  $T_g$ ), while relating it to the crank angle CA, on the basis of a state quantity of the cylinder interior gas at the time of start of compression ( $CA_{in}$ ) (heat energy of the cylinder interior gas at the time of start of compression), the amount of a change in the state quantity of the cylinder interior gas attributable to compression in a compression stroke (minute piston work), and the heat generation quantity of a cool flame generated in PCCI combustion prior to autoignition (hot flame) (cool flame heat generation quantity  $\Delta Q_{lto}$ ). A time when the cylinder interior temperature  $T_g$  reaches a predetermined autoignition start temperature  $T_{ig}$  is estimated as an autoignition start time ( $CA_{ig}$ ) of the premixed gas mixture related to PCCI combustion. Since the cool flame heat generation quantity  $\Delta Q_{lto}$  is taken into consideration, the autoignition start time related to PCCI combustion can be estimated accurately.



PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SM, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

- (84) **Designated States** (*unless otherwise indicated, for every kind of regional protection available*): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

**Published:**

- with international search report
- before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments

*For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*